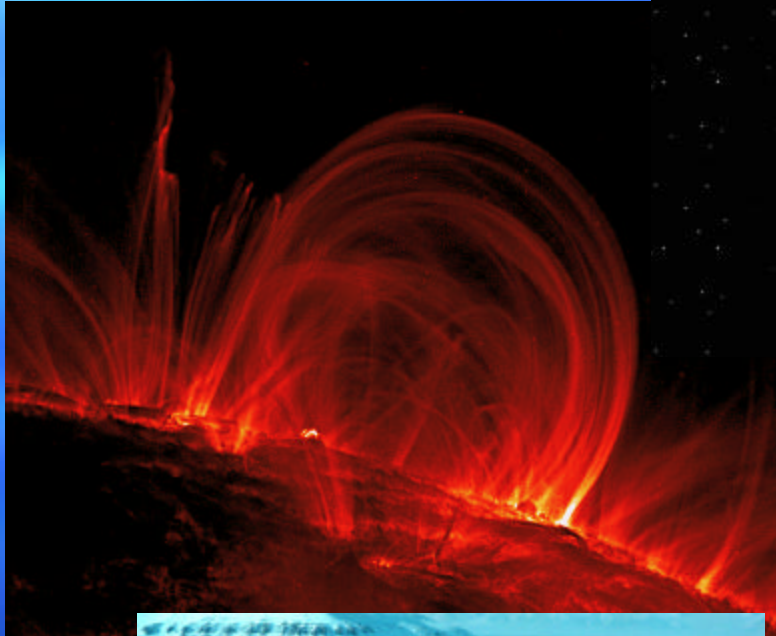




Potential ESA Contributions to International Living With a Star



NASA ESA *International* Japan Russia Canada ...



LIVING WITH A STAR



Inter-Agency
Consultative
Group



ILWS should, from a European point of view, contain more than the NASA LWS Line and international add-ons...

... rather like a global and and more quantifying follow-up of the successful ISTP program.

Many Solar and STP missions in the US, Europe and elsewhere fulfill the requirement of increasing our understanding and our capability to predict the planetary terrestrial response to Solar drivers, if properly coordinated

Climate Change



Main Themes of ILWS:

... to understand the governing processes
of the connected Sun-Earth system...

... as an integrated entity.

→ simultaneous and coordinated observations

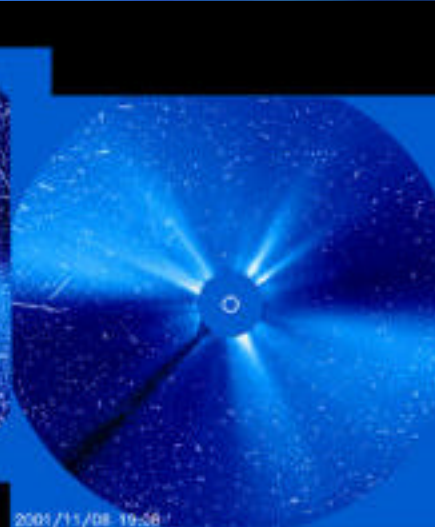
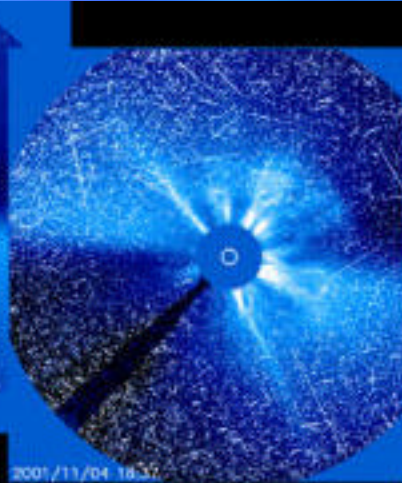
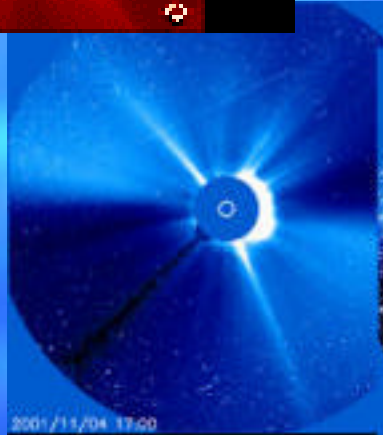
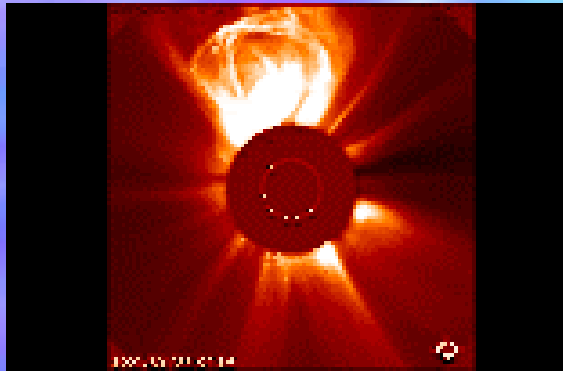
→ at strategic locations in the entire system



1. Solar and Heliospheric Physics

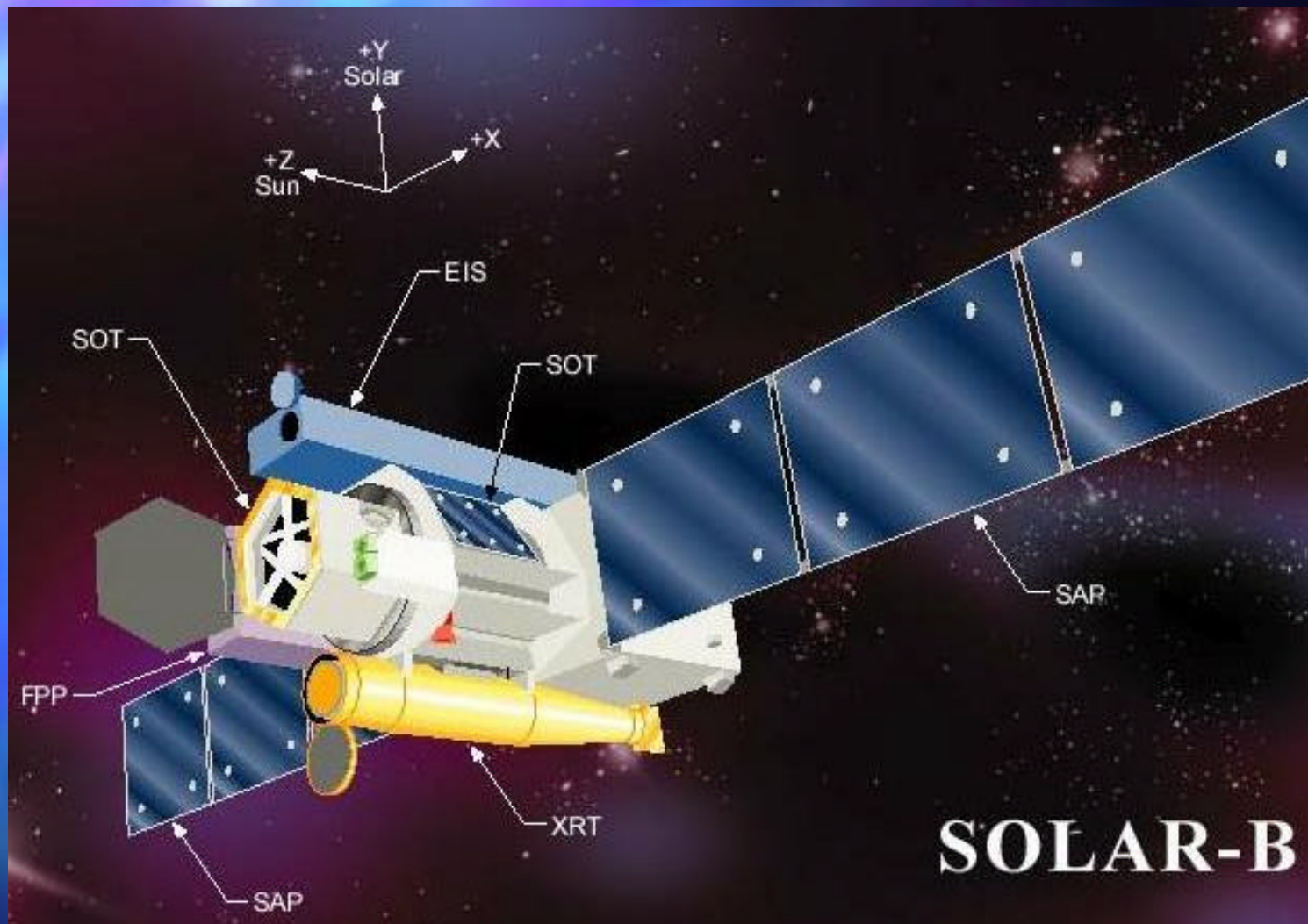
Potential ESA - ILWS Contributions

SOHO: ESA's Solar Cornerstone Mission



Solar Observation Satellite:
ESA / NASA Collaboration
4 year mission extension granted
2003-2007

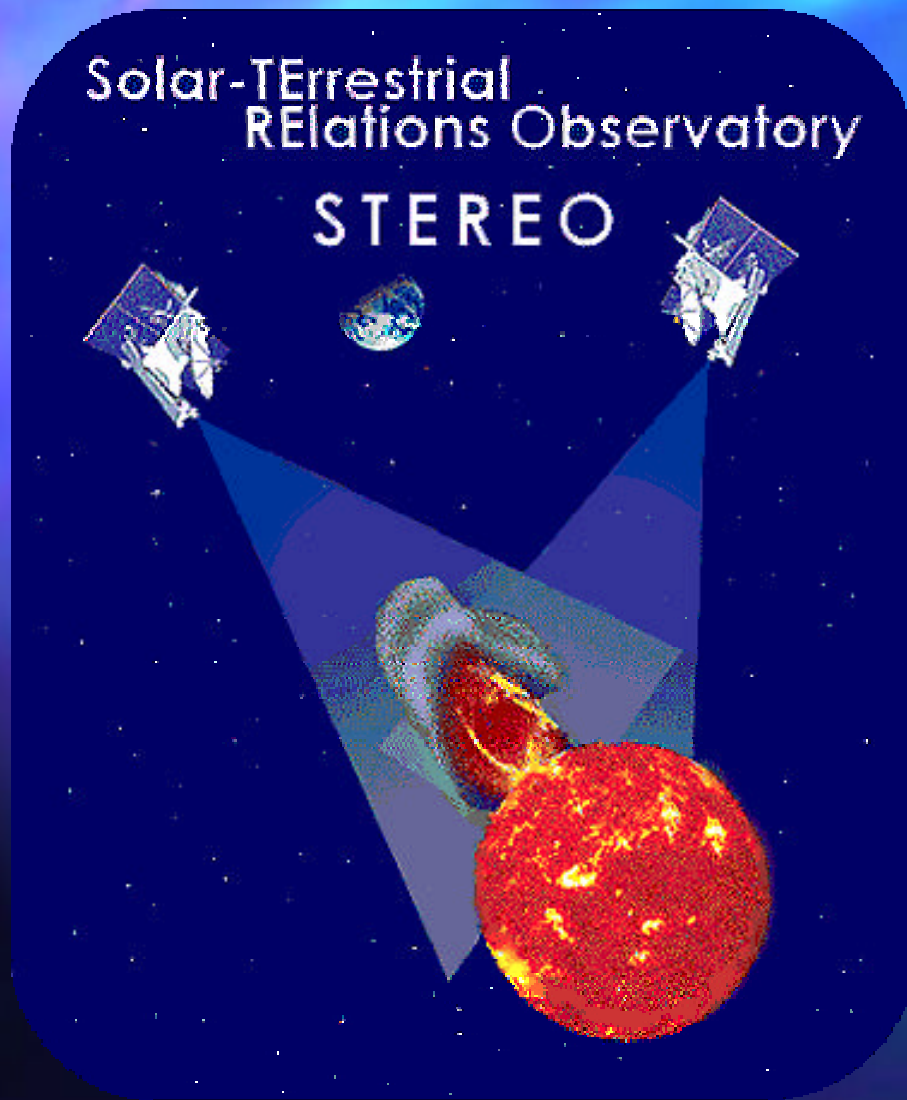




Next Japanese Solar Mission with NASA Participation
(Ground Station Support from ESA close to agreement)
Launch late 2005

STEREO and SDO - Solar Dynamics Observatory

"Targets of Opportunity"



Both NASA missions
Stereo and SDO
will contain a
considerable European
payload participation

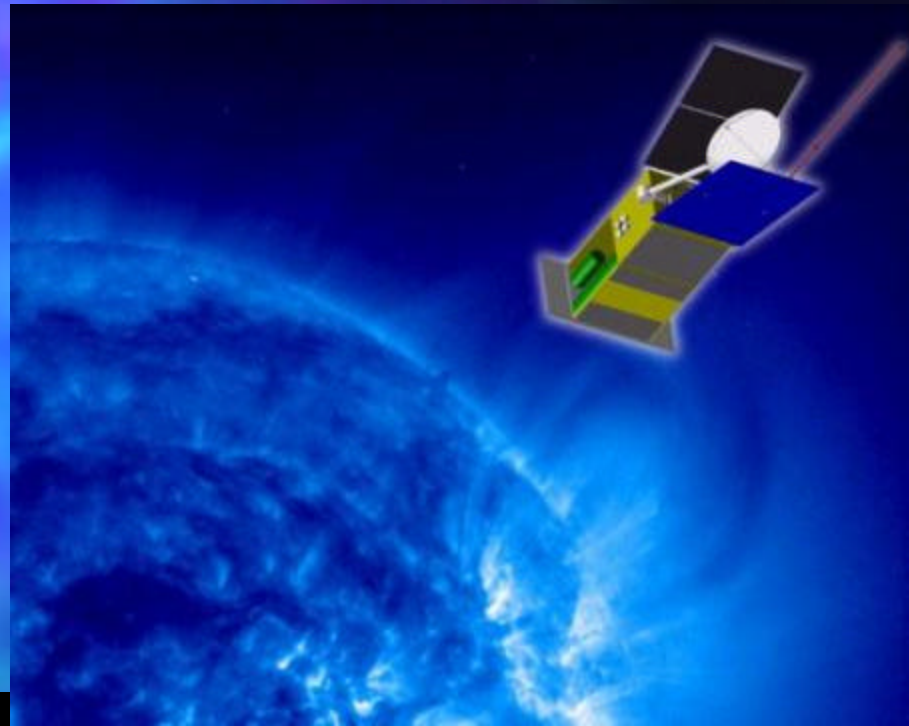
ESA considers to contribute
to STEREO and/or SDO and
also play a co-ordinating role in
payload provision from Europe

Launches: 2005 and 07

Solar Orbiter

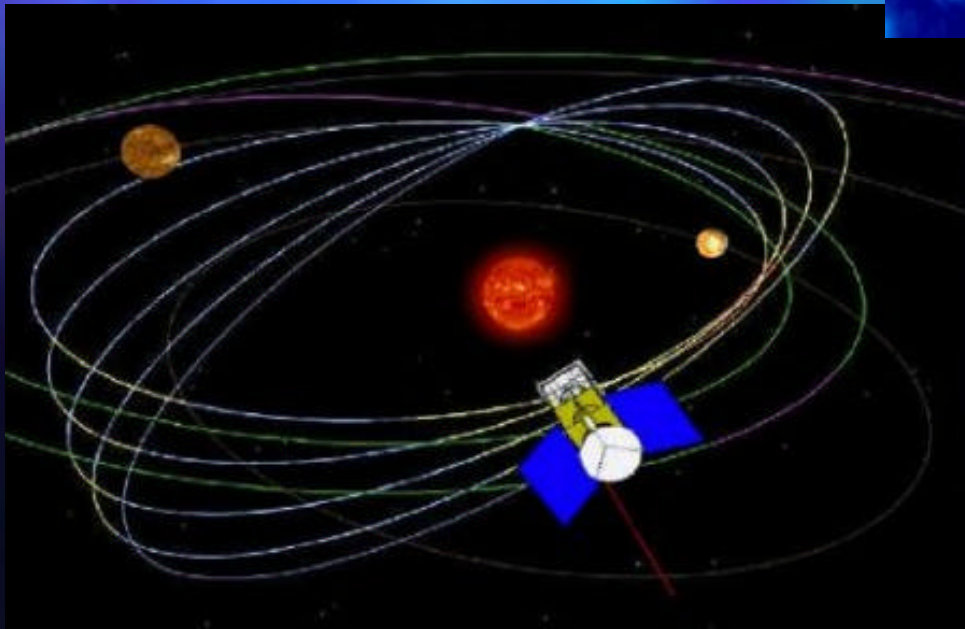
ESA-ILWS Flagship
in the long term

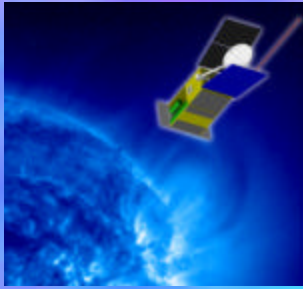
- Selected as ESA F-mission
- to be launched within the next 10 years
- lifetime 5 + 2 years
- **NASA participation under establishment**



Inner Heliosphere in-situ
and Solar Remote Sensing

Orbit up to 38 deg out of the
ecliptic plane, i.e. topside view
of polar regions, CME's and
the backside of the sun





Solar Orbiter: **Mission Firsts**

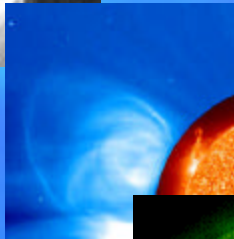
- explore the uncharted innermost regions of our Solar system
- study the Sun from close-up (45 solar radii or 0.21 AU)
- fly by the Sun tuned to its rotation and examine the solar surface and the space above from a co-rotating vantage point
- provide images of the Sun's polar regions from heliographic latitudes as high as 38°

Planned Future International Solar Missions



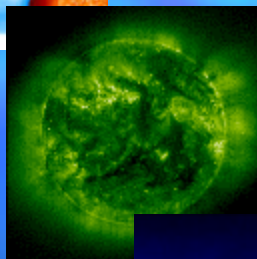
Solar-B [2005] – ISAS (+ NASA & ESA)

More Detail, Magnetic Field



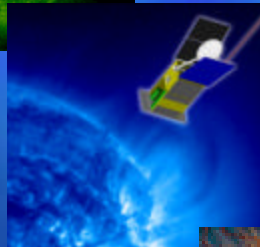
STEREO [2005] – NASA (+Europ. groups +ESA)

Out of Sun-Earth Line, 3-D, CMEs



Solar Dynamics Obs. [2007] – NASA (+ESA)

More Details, Helioseismology, CMEs



Solar Orbiter [2011+] – ESA (+NASA)

Out of Eccliptic, Far-Side, Co-Rotation,
Inner Heliosphere/Corona



Solar Probe - NASA

A Closer look

Solar Sentinels – NASA

Multipoint Inner Heliosphere

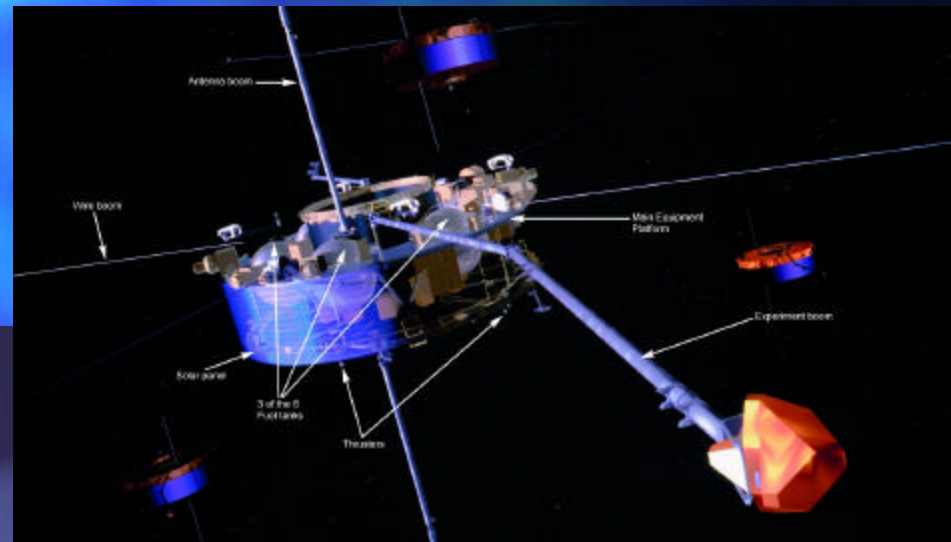
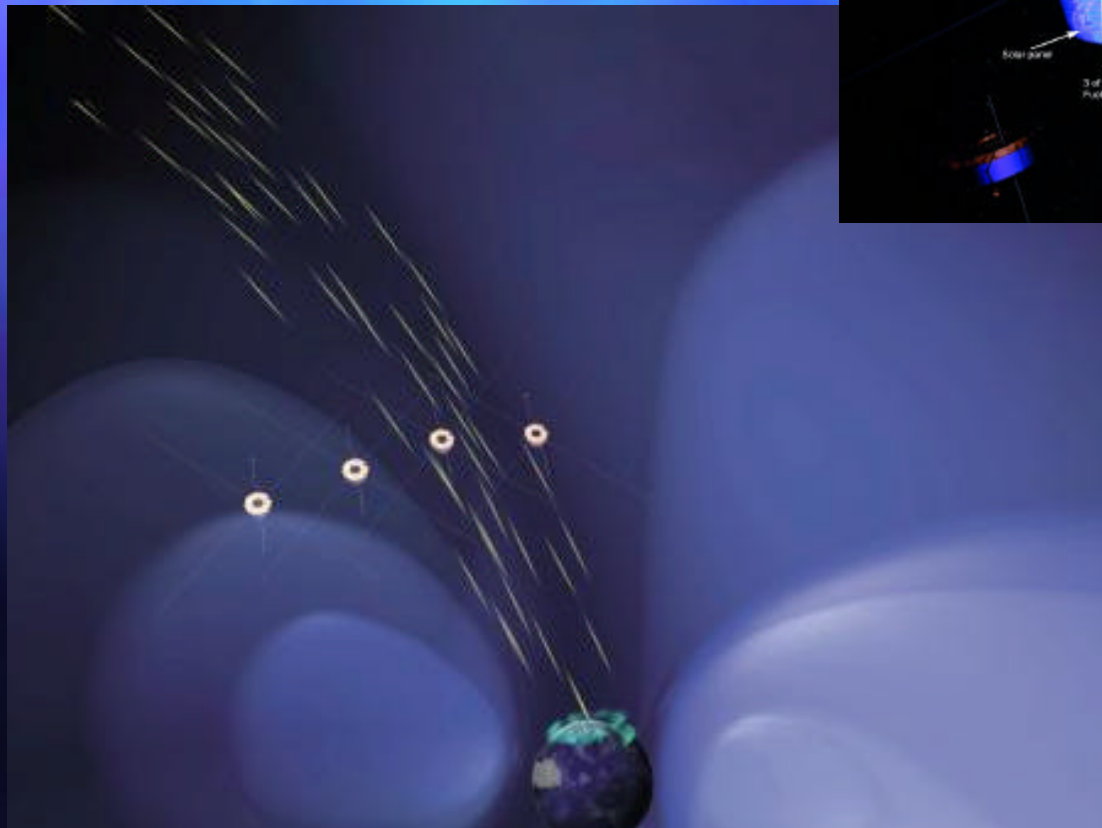


2. Magnetospheric / Ionospheric Physics - STP or SPP

Potential ESA - ILWS Contributions

Cluster

ESA's Magnetospheric Cornerstone Mission



ESA-SPC decision made
on 100 % orbital data
coverage and 3 year
mission extension
For 2003-2005

DOUBLE STAR

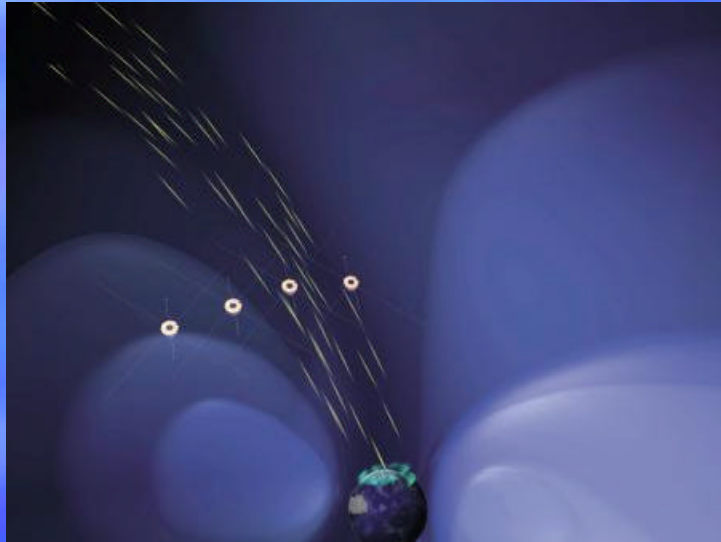
Chinese / ESA / European Collaboration



**Two satellites equipped mainly with Cluster Spare Instruments
in Magnetospheric Polar and Equatorial orbits**

DSP –E: 550 km x 60000 km and DSP-P: 350 km x 25000 km

Launches in 2003 and 2004, resp.



CLUSTER Active Archive Phase

Recent plan to establish a public-domain high-resolution data archive for the CLUSTER mission
- including multi-instrument value-added satellite and G-B data.

Proposal to be discussed and presented to ESA SPC in 2003
Presently evaluated within the Cluster Science Working Team
following a proposal from D/Sci in September 2002

”Bepi Colombo”

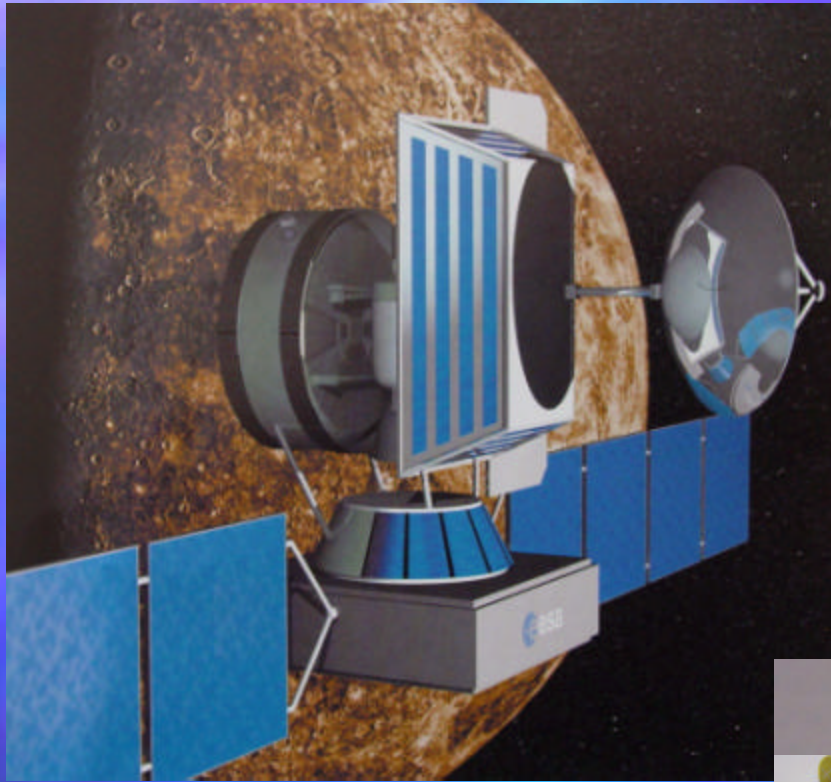
ESA’s Cornerstone Mission to Mercury



Mercury Magnetospheric Orbiter, MMO
(in close collaboration with Japan)

A Magnetospheric Mission to investigate
Solar Wind / Magnetosphere Interaction
without a Planetary Ionosphere

(also an ”Inner Heliospheric Sentinel” mission)



”Bepi Colombo”

consists of :

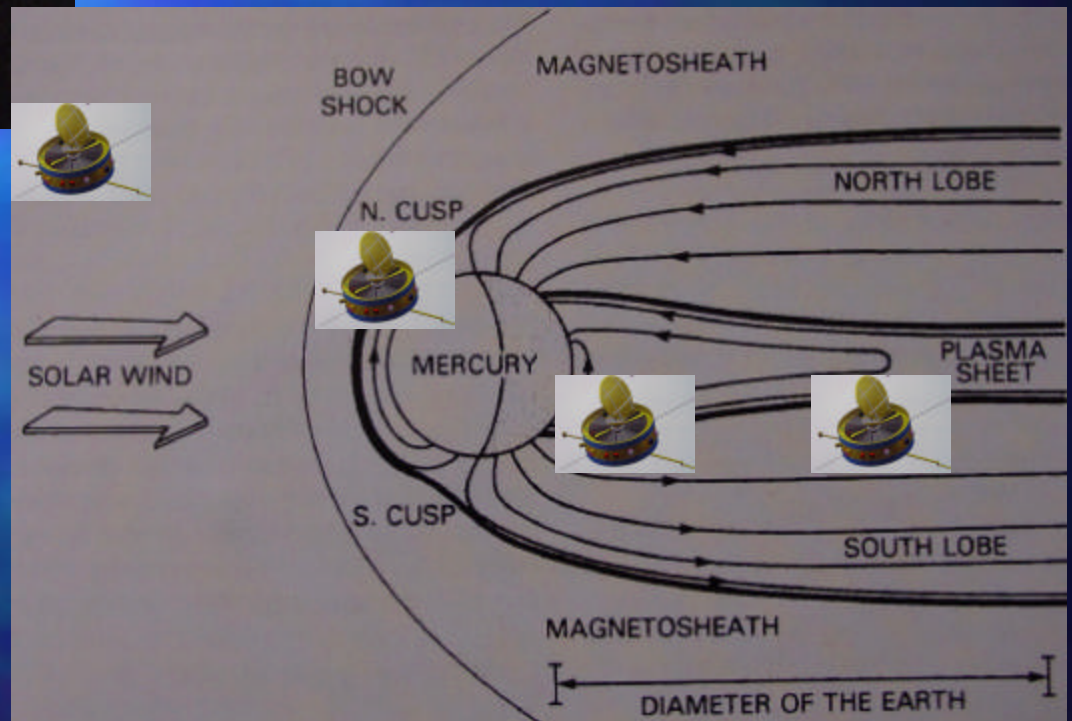
MPO, MSE, and MMO

Launches 2010/2011

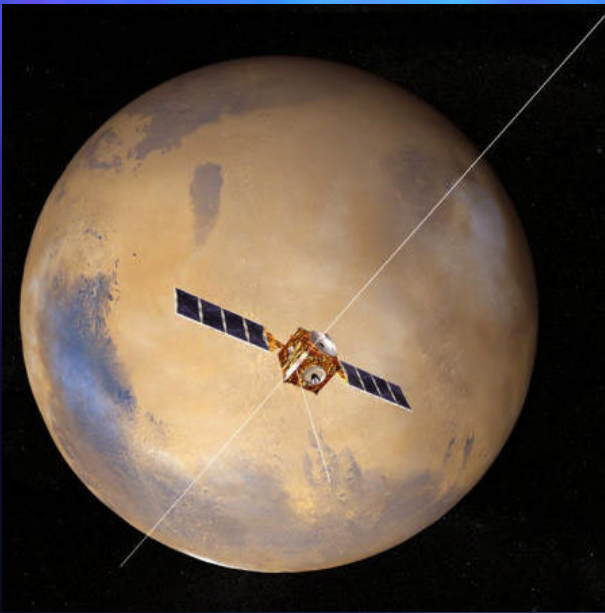
MMO →

in two orbit
locations:

at 400 km and
at 12000 km

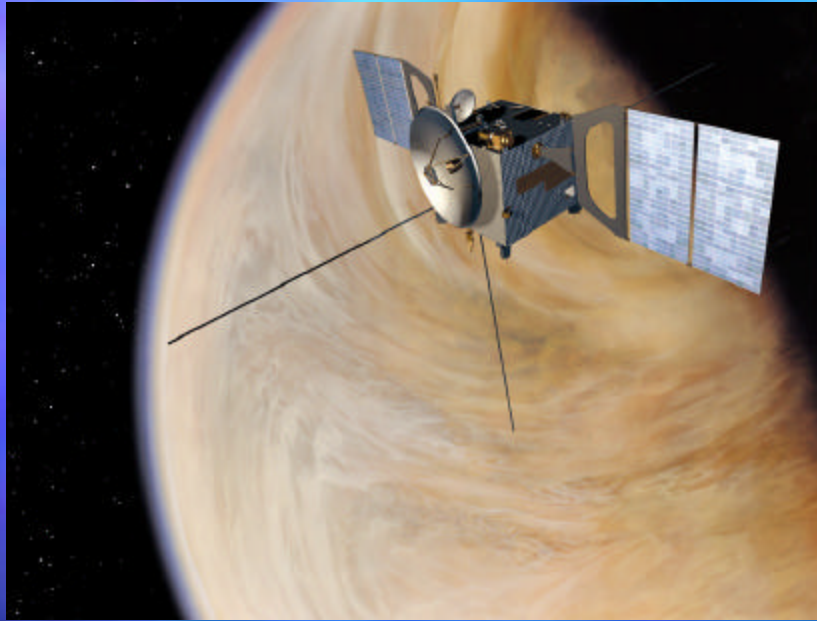


Mars Express



- ASPERA: Energetic Neutral Atoms Analyser
- HRSC: High/Super Resolution Stereo Colour Imager
- MaRS: Radio Science Experiment
- MARSIS: Subsurface Sounding Radar/Altimeter
- OMEGA: IR Mineralogical Mapping Spectrometer
- PFS: Planetary Fourier Spectrometer
- SPICAM: UV and IR Atmospheric Spectrometer
- The BEAGLE-2 lander (Search for evidence of life)

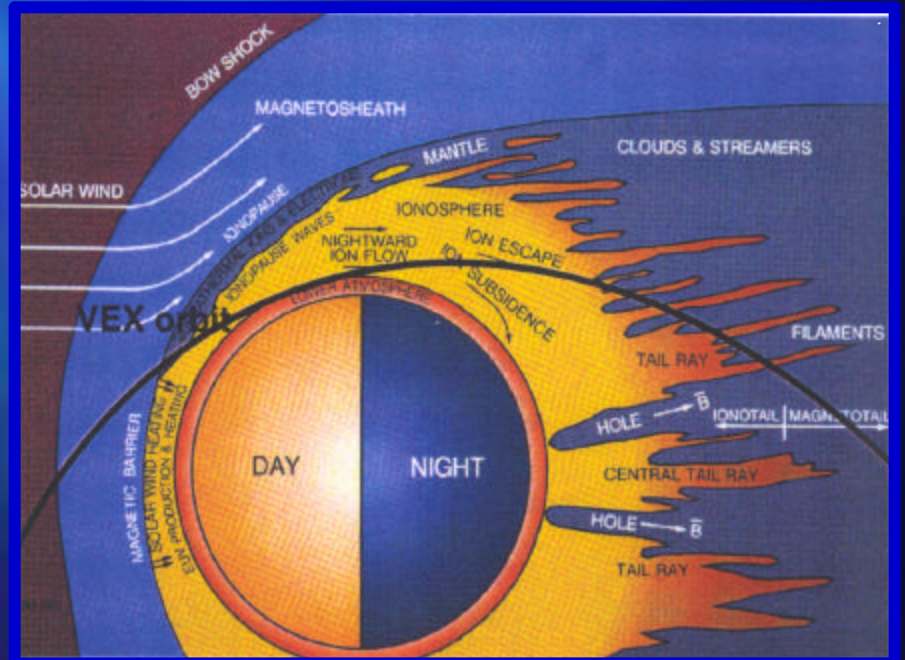
Venus Express



- *ASPERA: Analyser of Space Plasmas and Energetic Atoms*
- *PFS: High-resolution IR Fourier spectrometer*
- *SPICAV: UV and IR spectrometer*
- *VeRa: Venus Radio science instrument*
- *VIRTIS: UV-visible-IR Imaging Spectrometer*
- *VENSIS: low frequency radar sounder*
- *VMC: Venus Monitoring Camera*
- + *a Magnetometer*

...will address the problems of atmospheric escape and plasma environment by

- in situ measurements of ENA, ions, electrons, and magnetic fields
- active radar sounding of the vertical structure of the topside ionosphere;
- high-resolution spectroscopic observations of CO₂ and H₂O
- remote sounding of the solar wind turbulence.



**...in addition ESA considers to support other
European missions within the ILWS realm**

(national, as well as bi- and multi-lateral projects)

**A new procedure for ESA support of "nationally-led missions"
may enhance the capabilities of individual memberstates or
consortia to contribute missions to the ILWS programme.**

**A First Call was presented to ESA delegates in early July, and
the same procedure will be repeated every year in the future.
(annual closing date September 15)**

ESA's contribution can be up to 15 % of the mission cost

A number of magnetospheric missions or mission concepts have been proposed and will be (re-)considered in the near future. Many if not all of them are multi-satellite missions, e.g.

- S(ch)warm (Germany, UK, Danmark ++)
- Storms (Finland ++)
- Heracles (France ++)
- Maxwell, Apex, (UK ++)
- Auroral Quartett (Sweden ++)
- MMM or short M³ (ESA Solar System Working Group)



Solar and Magnetospheric Science Community Meetings in spring of 2002 discussed strategies (& reassessment) for the "After- SOHO / CLUSTER Era", including ILWS

A long term future ESA Strategy - Vision 2020 will be discussed and formulated in 2003

Dayside Magnetopause



Reconnection
Acceleration
Turbulence
Solar wind entry

Post-Cusp Magnetopause



Northward reconnection
Reverse convection
Pointing flux entry

MMS

Considered as
"TARGET OF OPPORTUNITY"
by European STP community

- European participation in both competitive US Pi-Consortia
- A dedicated ESA contribution and ESA co-ordination of the European payload provision is under discussion.

Phase 1

Phase 2

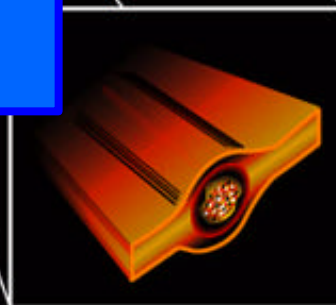
Plasma sheet boundary
Acceleration
Current disruption



Nightside
Substorm Region

Phase 3

Reconnection
structures and
dynamics
Plasma escape
and motion
across boundaries



Magnetotail

Potential options for collaboration on MMS

- 5th spacecraft
 - could be instrumented at a reduced level based on those measurements which most critically depend on a 5th spacecraft
- Launch
 - could enable more capable instrumentation on spacecraft or perhaps free funds to return the 5th spacecraft
- Inter-spacecraft ranging and alarm system
 - requirements will be determined by selected ISST
- Additional ground station
 - later involvement with mission ground operations
- Propose for Interdisciplinary Science Investigation
 - an opportunity to become involved with MMS science in the early phases - no hardware commitment

Other
"targets of opportunity" :

Mission scenarios for the
detailed study of ionospheric
and inner magnetospheric
responses (**Geospace-Regions**)

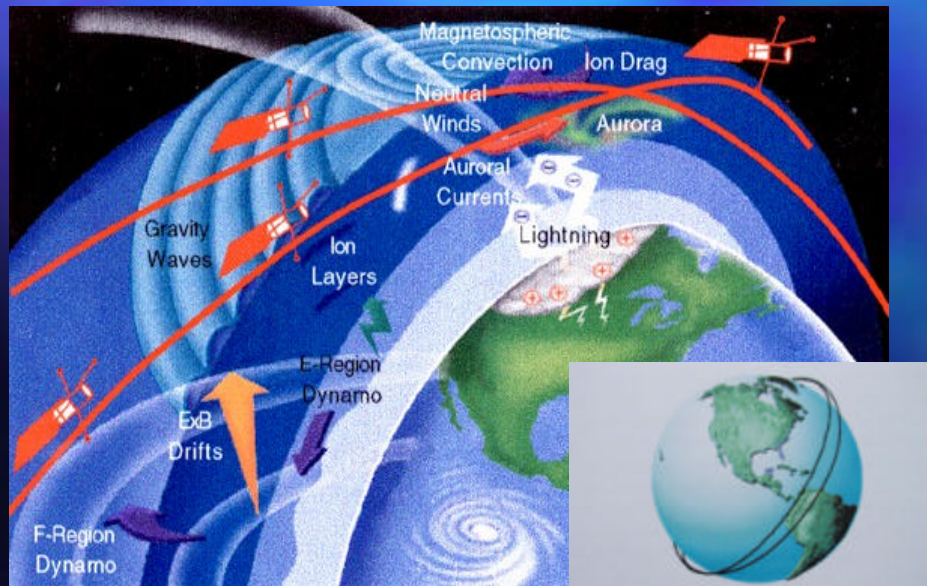
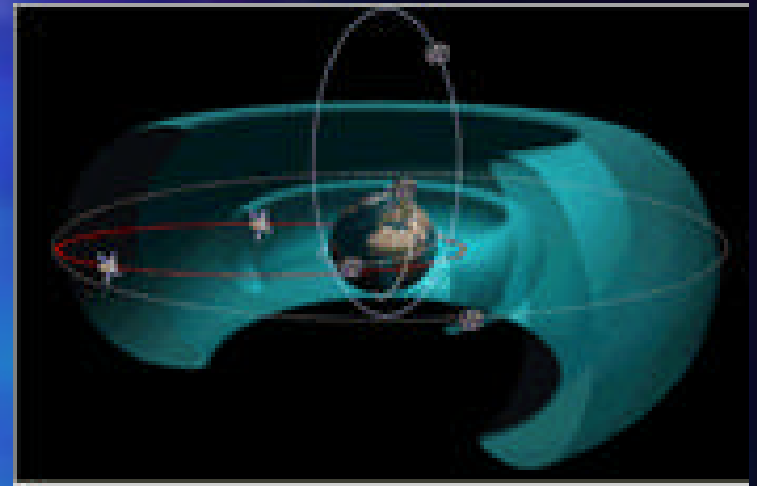
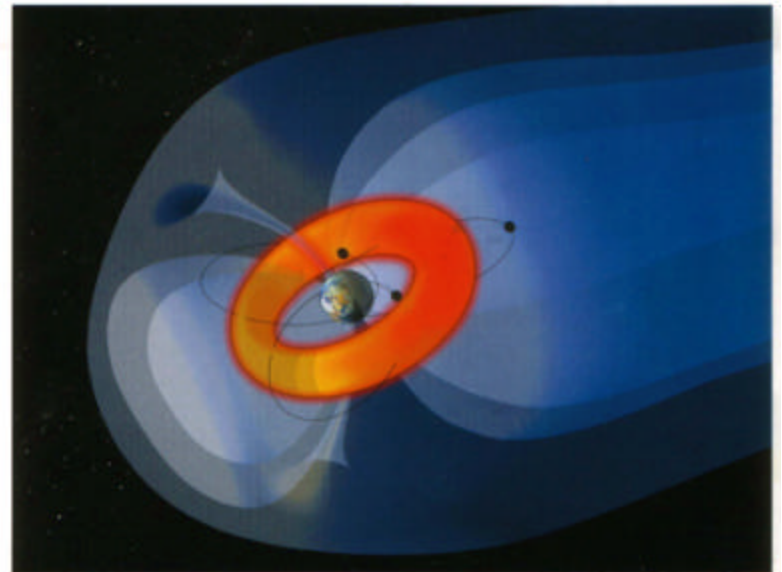


Figure 2-3. Ionosphere-thermosphere science element orbit.

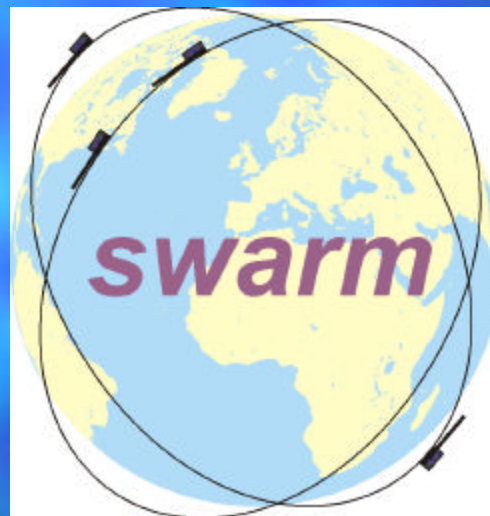


Compare **STORMS**

**A Three-Spacecraft Constellation for
Earth Magnetic Storms and
Inner Magnetospheric Studies**



A Multi-Satellite Mission called **SWARM**
(Danish Proposal) was recently selected within
ESA's Earth Observation Programme



Primary aim of SWARM: Internal magnetic field dynamics

Secondary aim of SWARM: Ionospheric / atmospheric coupling via magnetically controlled processes

Current ESA Status: Phase A study within D/EOP
with D/SCI involvement

ESA's D/TOS Space Weather Initiative:

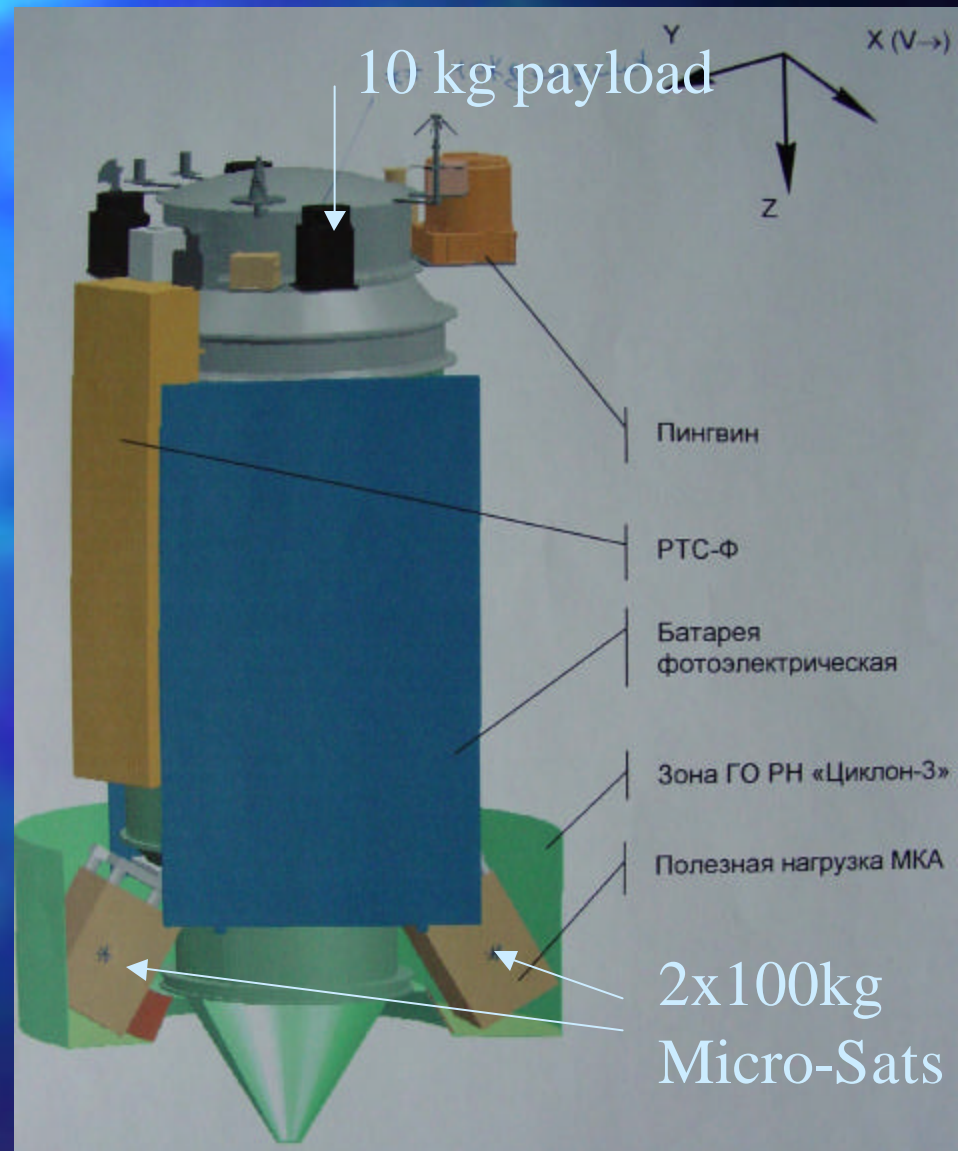
A 2-year Space Weather pilot study has recently been approved within the ESA GS-Program

Expected outcome of this pilot study:

- European Customer identification
- Product definition and data prototype presentation
- Network establishment with US, Japan and Russia
- Plus quite logically a proposal for a first
ESA Space Weather Demonstration-Mission
(which consequently could be coordinated with
and / or implemented into the ILWS fleet)

Opportunity for collaboration with Russia

Ongoing discussion between ESA and Rosaviakosmos about a possibility to launch two Micro-Satellites at 100 kg each with the Russian Koronas-Photon mission into high inclination orbits at 500 km altitude.



In addition: A New Element of Enhanced Collaboration
with Ground-Based Networks to Study Global Responses
to Solar Wind / Magnetosphere Interaction Drivers

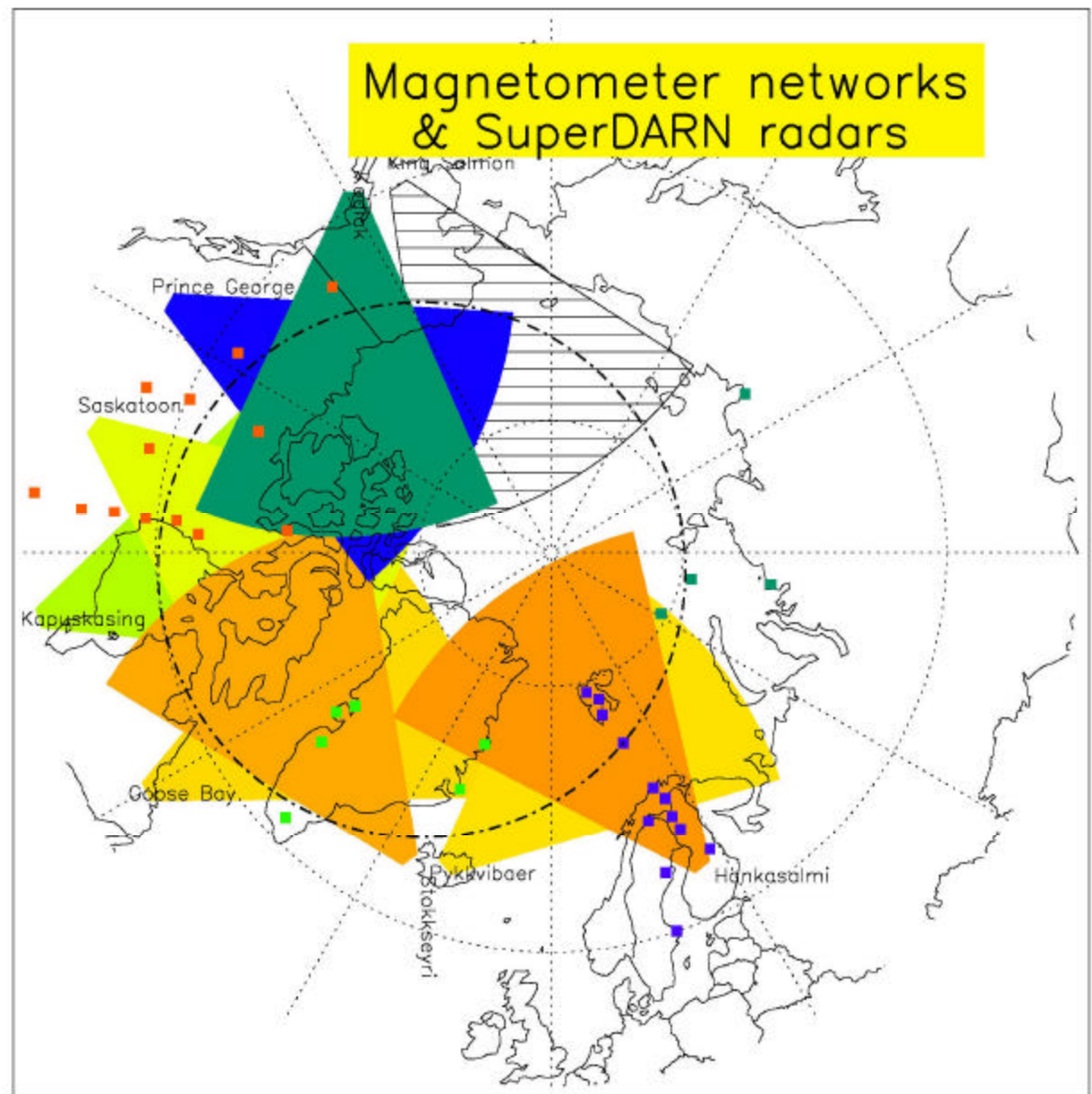


Global Ground-Based Networks

In Northern
(and Southern)
Hemisphere

Value-added
Data Products
(MIRACLE,
SuperDARN)

(Canadian
Part funded
by CSA)



++ Southern Hemisphere : Halley, SANA, Syowa South, Syowa East, TIGER, Kerguelen

European Incoherent Scatter Facility - EISCAT



Three Incoherent Scatter Radars
New Widened Association 2006



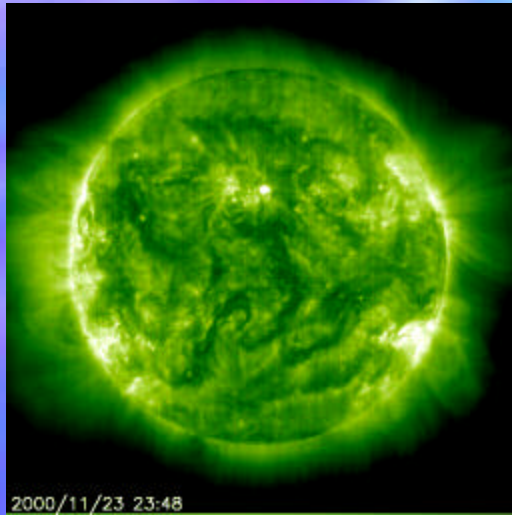
EISCAT

- Three co-operating installations forming an array of radars
- The world's only multi-static Incoherent Scatter radar (KST)
- Complementary to the US radars in Millstone Hill and Søndre Strømfjord
- From 2006 new and widened organisation **e'** ("e-Prime")



The **e'** Proposal: Role and Products

- **PRIME** (Principal Research Into Man's Environment)
 - Ionospheric data, on time, all the time
 - Value added data services and organization to attract other instruments and data providers.
 - Data synthesis products, including:
 - Incoherent and Coherent Scatter Radar data
 - Optical and Magnetometer data, Models
 - Dependable, reliable, quality assured data for both routine, event driven, and statistical use.
 - Scalable, responsive data products tailored to the needs of non-specialist and specialist users alike.



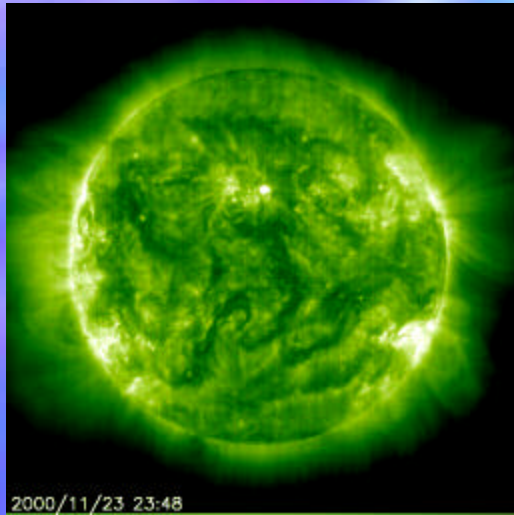
C o n c l u s i o n s

ESA and the ILWS (Existing Program)

- Two ESA Cornerstone Mission extensions - CLUSTER and SOHO
- Participation in the Chinese DOUBLE STAR Mission
- Space Plasma Package on Mars-Express (and Venus-Express ?)

MIND THE GAP...

- BepiColombo – MMO in close collaboration with Japan
Mercury Magnetospheric Orbiter & Inner Heliospheric Sentinel
- The ESA F-Mission SOLAR ORBITER as an ILWS Flagship
(future collaboration with NASA anticipated, t.b.d.)



C o n c l u s i o n s

ESA and the ILWS

(Potential contributions)

- The Cluster Active Archive Phase
- Ground station support for the Japanese SOLAR-B Mission
- "Targets of opportunity" for European payload and/or ESA contributions: SDO, Stereo, MMS, or other ILWS missions...
... e.g. in the near-term ESA ground station support for Stereo and Inter-Space-Craft Ranging Facility for MMS
- A new initiative within ESA D/Sci for "Nationally Led Missions"
- Collaboration across different ESA directorates (Swarm – D/EOP , Space Weather – D/GS)
- Collaboration with Russia concerning ILWS launch opportunities (A new approach to large scale ground-based instrument networks)

How do we go about ?





Strategy for an ESA-NASA Collaboration within ILWS

- Separate ILWS missions into an early and a later part
Early part including SDO, STEREO, MMS, GEOSPACE, and GEC missions (i.e. LWS and STP)
Later part including Solar Sentinels, Solar Orbiter, SolarProbe?
- Identify possible ESA contributions to an early package of ILWS missions (within the NASA LWS and STP programmes)
- Prepare for a continuation of this collaboration during the later ILWS by a common
Solar Sentinel / Solar Orbiter Science Definition Team
- Note: parallel future plans for multi-microsatellite missions (MagCon - NASA vs Swarm - M³ - ESA)

Joint Solar Orbiter-Solar Sentinels WG

- Kick off in fall 2002 – after new NASA Decadal Survey and SEC Roadmap
- 5-6 members each from European and US scientific communities (+ agencies)

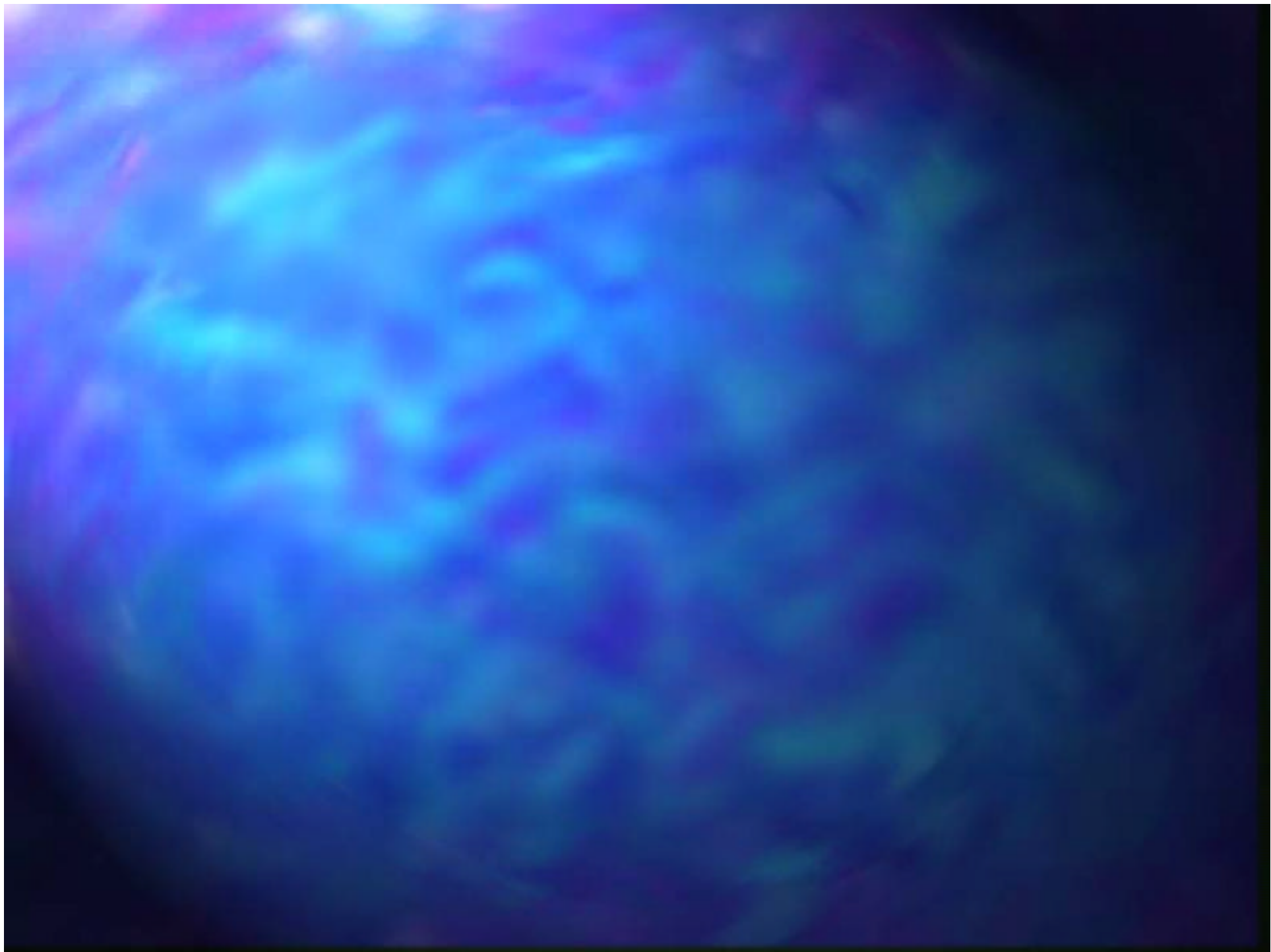
Charter:

Synthesize goals of the Solar Orbiter and Solar Sentinels as presently defined into a prioritized set of science objectives enabling the ILWS program to achieve its goals.

(1) Optimize the scientific cost benefit devising an implementation strategy which combines respective resources.

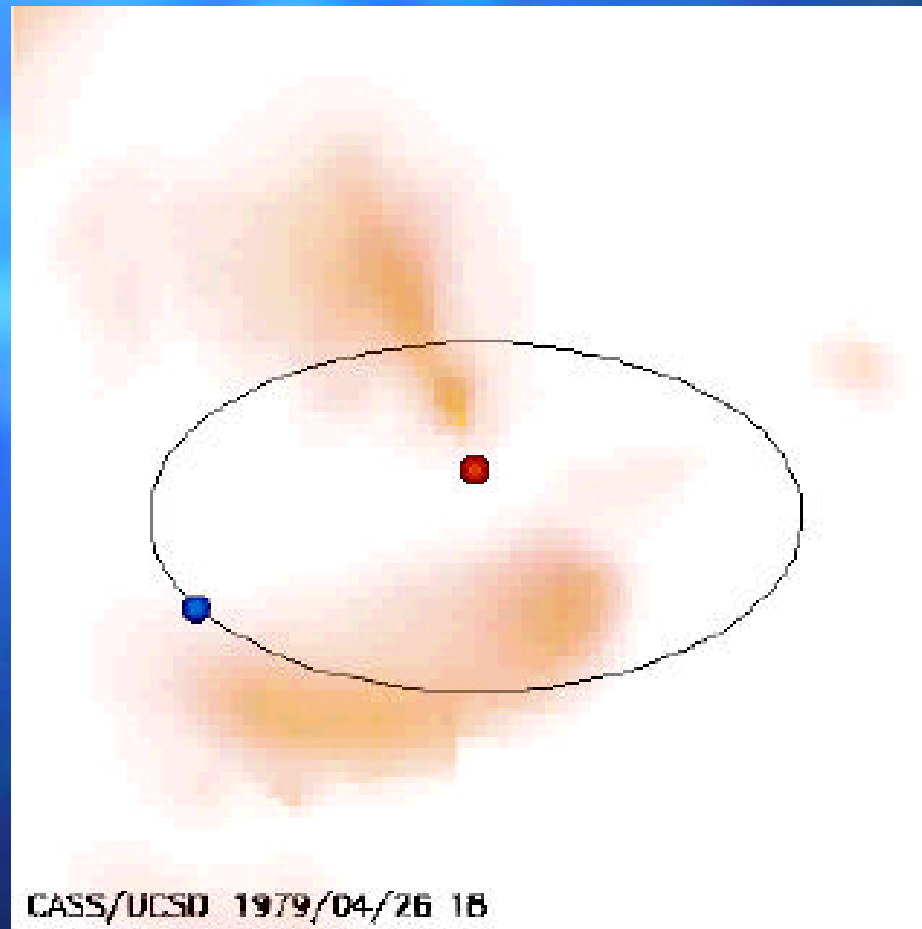
(2) Identify the key science objectives which can only be accomplished jointly, but not separately.

(3) Suggest combined mission scenario options to accomplish ILWS goals.



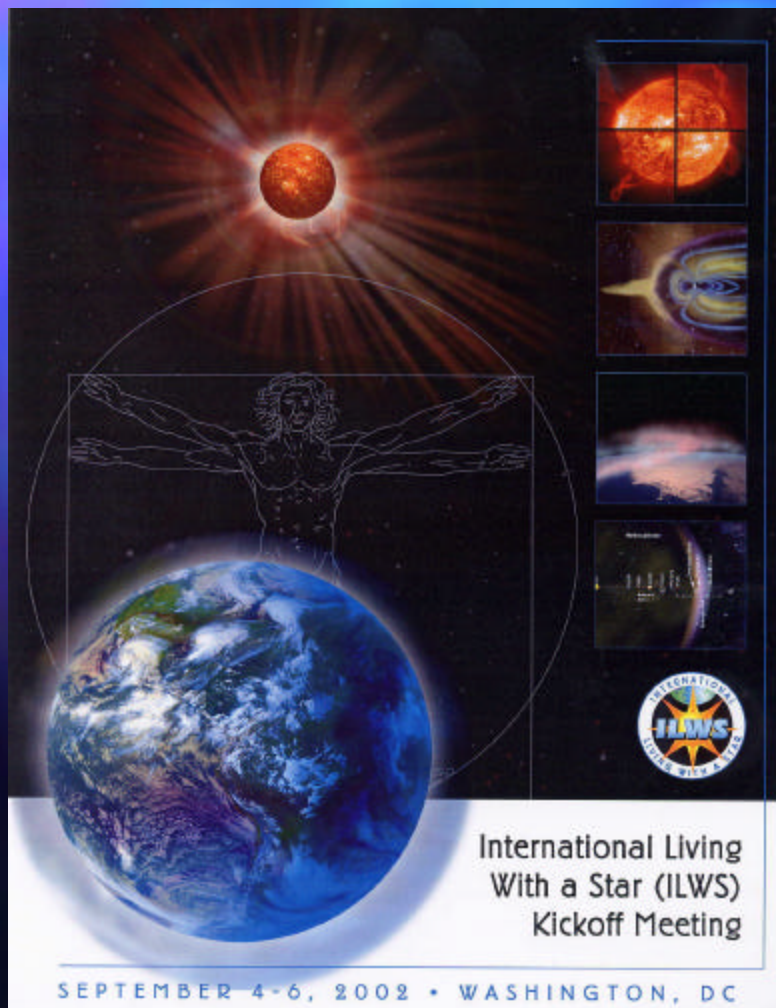
CME Movie Based on Interplanetary Scintillation data

Earth →



← Sun

Initial Meeting of the International Living With A Star Working Group (ILWS-WG)



- Convened as per IACG decision
- First meeting held Sept. 4-6, 2002 in Washington DC
- 29 attendees -27 agencies invited
- 4 IACG members
- 7 National Space Agencies
- Acting Chair R. Fisher, NASA SEC Director

Charter of the ILWS-WG I

ILWS-WG MISSION



- Stimulate, strengthen and coordinate space research to understand the governing processes of the connected Sun-Earth System as an integrated entity

Charter of the ILWS-WG II

ILWS-WG Objectives



- To stimulate and facilitate:
 - Study of the Sun Earth connected system and the effects which influence life and society
 - Collaboration among potential partners in solar-terrestrial space missions
 - Synergistic coordination of international research in solar-terrestrial studies, including all relevant data sources as well as theory and modeling.
 - Effective and user driven access to all data, results and value-added products

Charter of the ILWS-WG III

ILWS-WG Membership



- Space organizations committed to contribute to ILWS over the next decade
- Contributions to include any of the following
 - Space Flight Missions
 - Mission payloads or subsystems
 - Mission launch or tracking services
 - Additional data sources supporting flight missions (sounding rockets, balloon, or ground-based)
 - Data dissemination, storage, distribution and value adding systems
 - Supporting theory and modeling

Provisional Guidelines

ILWSP Structure - I



- The ILWS Program shall have a Steering Committee comprised of one member each from CSA, Russia, Japan, ESA and NASA
- The ILWS Program shall have a Working Group comprised of members from contributing agencies
- Topical ILWS Task Groups will be established as necessary to support specific ILWS-WG projects/studies.
- The ILWS-WG shall have a single Executive Secretary, which is provided by NASA
- Initial Chair of Steering Committee is provided by ESA

Provisional Guidelines

ILWS-WG Structure - II



- The ILWS Steering Committee will meet whenever considered necessary; preferably in conjunction with international meetings, like e.g. COSPAR in Houston
- Meetings of the ILWS-WG to be held once per year (or more often as necessary)
- Each ILWS- WG meeting will be chaired by the national representative of the host country.
- Meetings scheduled by consensus of membership of ILWS-SC and ILWS-WG

Provisional Organization ILWS-WG



Facilitation

System Concept
Coordination
Prioritization
Findings

Resources and
Opportunities
Data Systems

ILWS-WG Actions I



- Edit and produce minutes of first working group meeting and distribute through existing contact list.
- An ILWS-WG internet website to facilitate and broadcast ILWS-WG information shall be established and members notified.
- A first attempt at a master list of approved or nationally planned space flight missions of interest for ILWS shall be prepared in advance of the next meeting.

ILWS-WG Actions II



- Announcement of formation of the ILWS-WG via appropriate professional societies and website.
- Dr. G. Withbroe to present results of first ILWS-WG meeting at 2002 COSPAR, Houston TX, October 2002
- First meeting of the ILWS Steering Committee at 2002 COSPAR, Houston TX, October 2002
- Second meeting of ILWS-WG to be held in Nice, France at the time of the joint AGU-EGU meeting, April 2003

Informal Findings: First ILWS-WG Meeting



- Presentation of national and agency plans informing and illuminating to participants.
- Congruency between national programs and plans evident in several circumstances - ionospheric and magnetospheric missions 2005-2012.
- Obvious wide interest in heliospheric exploration in second decade of 21st century demonstrated by planned Solar Orbiter(ESA), B-C (ESA-Japan), L5 (Japan), Solar Probe, and Sentinels missions (USA).